FIG. 1

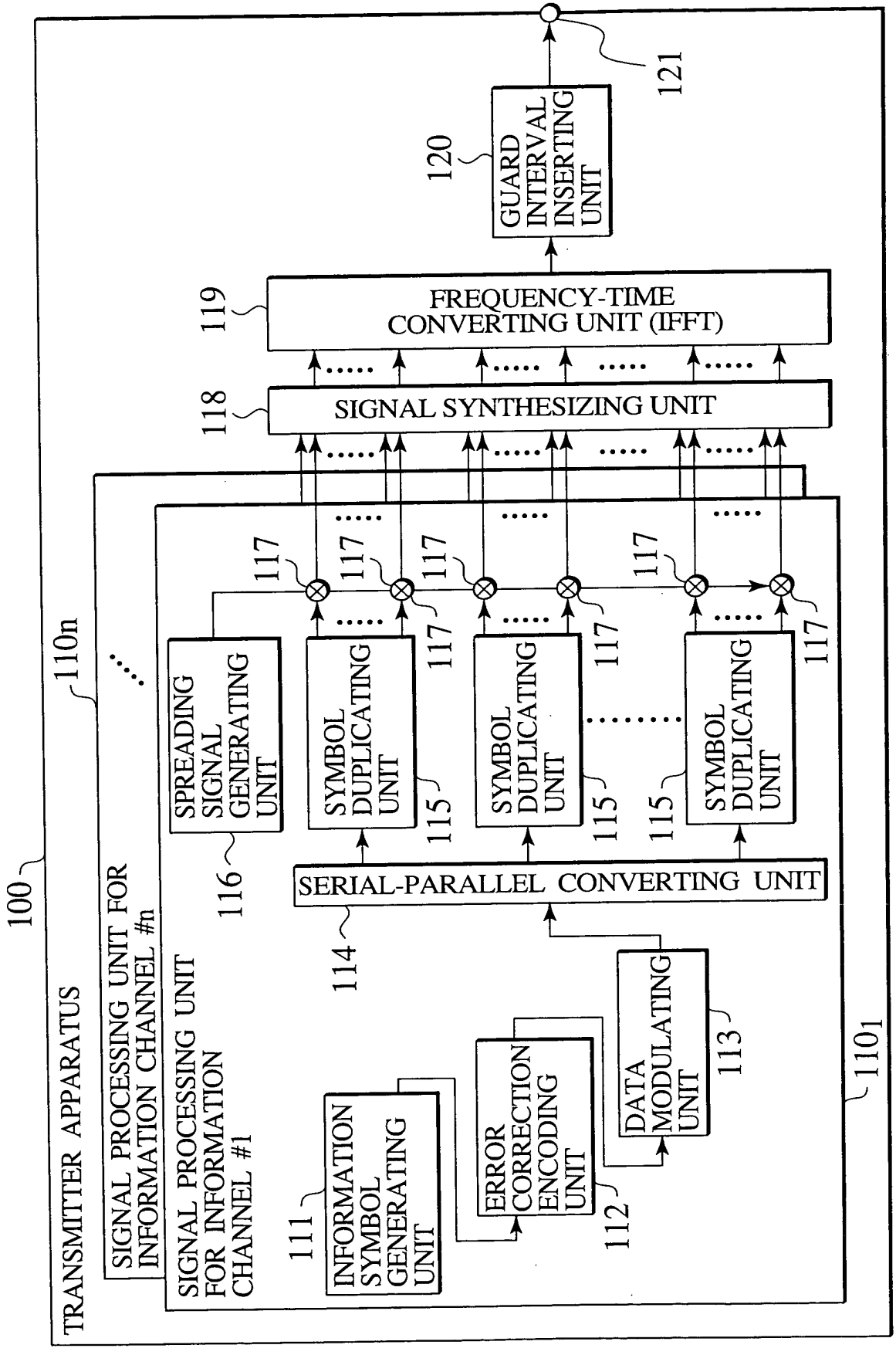

TRANSMITTER APPARATUS
100
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #n
110n
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #1
110₁
INFORMATION SYMBOL GENERATING UNIT
111
ERROR CORRECTION ENCODING UNIT
112
DATA MODULATING UNIT
113
SERIAL-PARALLEL CONVERTING UNIT
114
SPREADING SIGNAL GENERATING UNIT
116
SYMBOL DUPLICATING UNIT
115
117
SIGNAL SYNTHESIZING UNIT
118
FREQUENCY-TIME CONVERTING UNIT (IFFT)
119
GUARD INTERVAL INSERTING UNIT
120
121

FIG. 2

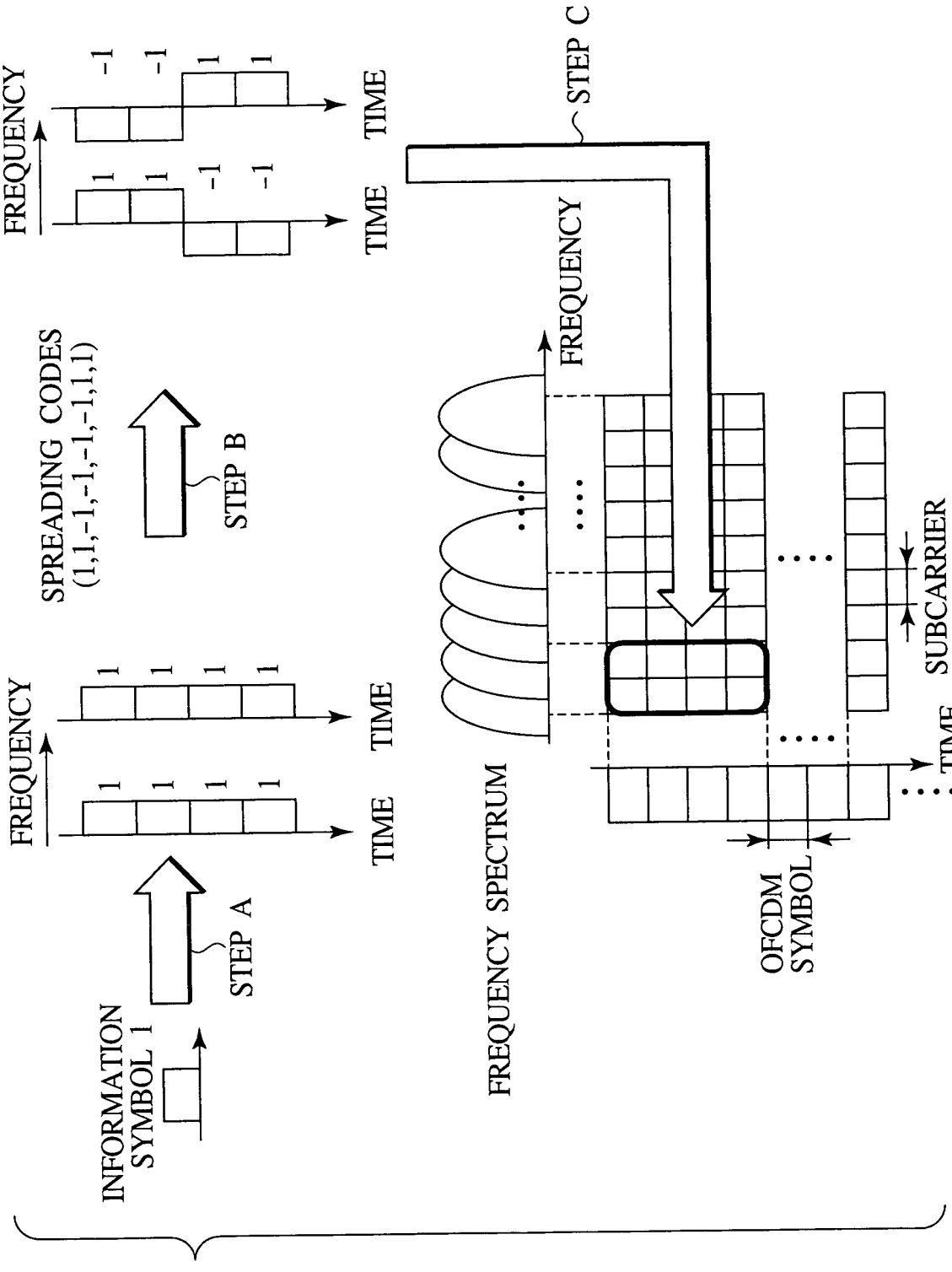

INFORMATION SYMBOL 1
STEP A
FREQUENCY
TIME
1 1 1 1
SPREADING CODES (1,1,-1,-1,-1,-1,1,1)
STEP B
1 1 -1 -1
-1 -1 1 1
STEP C
FREQUENCY SPECTRUM
OFCDM SYMBOL
SUBCARRIER

FIG. 3

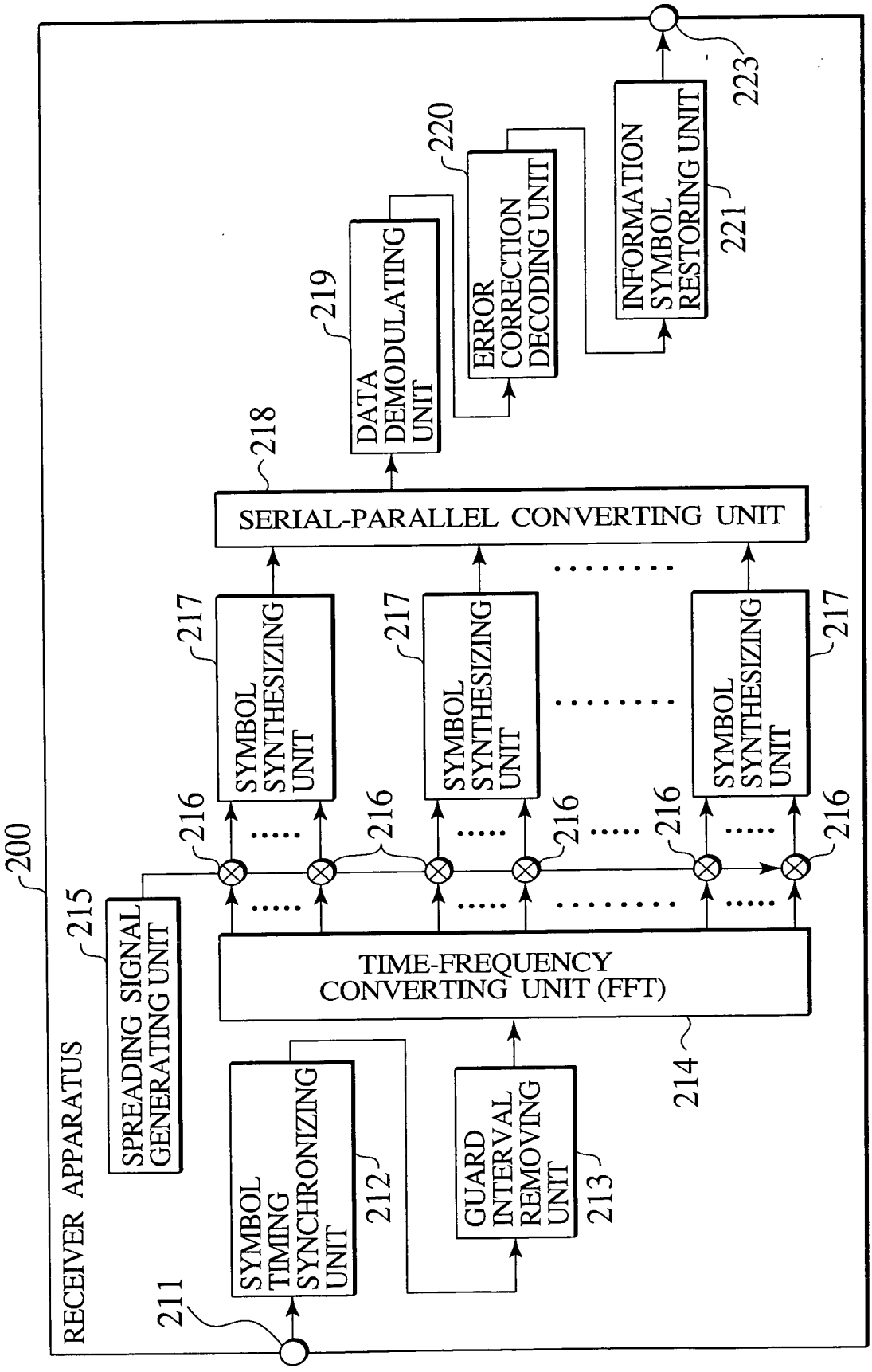

200
RECEIVER APPARATUS
211
SYMBOL TIMING SYNCHRONIZING UNIT
212
GUARD INTERVAL REMOVING UNIT
213
214
TIME-FREQUENCY CONVERTING UNIT (FFT)
215
SPREADING SIGNAL GENERATING UNIT
216
217
SYMBOL SYNTHESIZING UNIT
218
SERIAL-PARALLEL CONVERTING UNIT
219
DATA DEMODULATING UNIT
220
ERROR CORRECTION DECODING UNIT
221
INFORMATION SYMBOL RESTORING UNIT
223

FIG. 4A

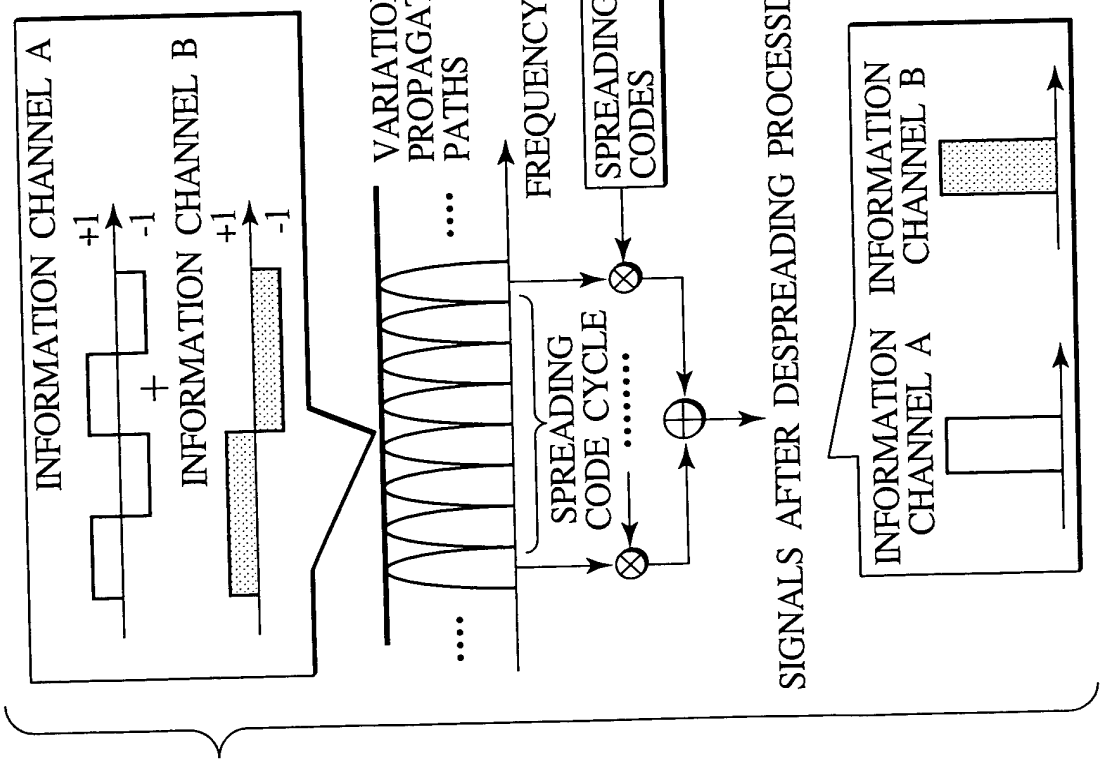

INFORMATION CHANNEL A
+1
-1
+
INFORMATION CHANNEL B
+1
-1
VARIATION OF PROPAGATION PATHS
FREQUENCY
SPREADING CODE CYCLE
SPREADING CODES
SIGNALS AFTER DESPREADING PROCESSING
INFORMATION CHANNEL A
INFORMATION CHANNEL B

FIG. 4B

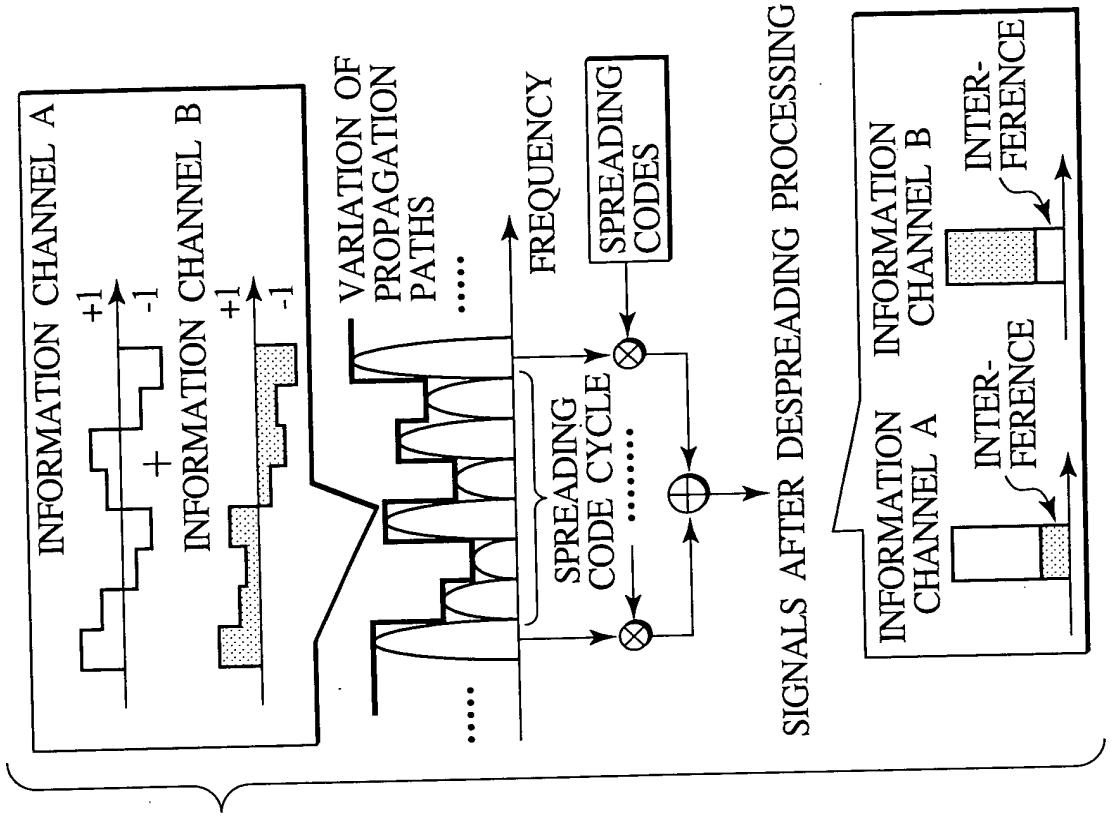

INFORMATION CHANNEL A
+1
-1
+
INFORMATION CHANNEL B
+1
-1
VARIATION OF PROPAGATION PATHS
FREQUENCY
SPREADING CODE CYCLE
SPREADING CODES
SIGNALS AFTER DESPREADING PROCESSING
INFORMATION CHANNEL A
INTER-FERENCE
INFORMATION CHANNEL B
INTER-FERENCE

FIG. 5

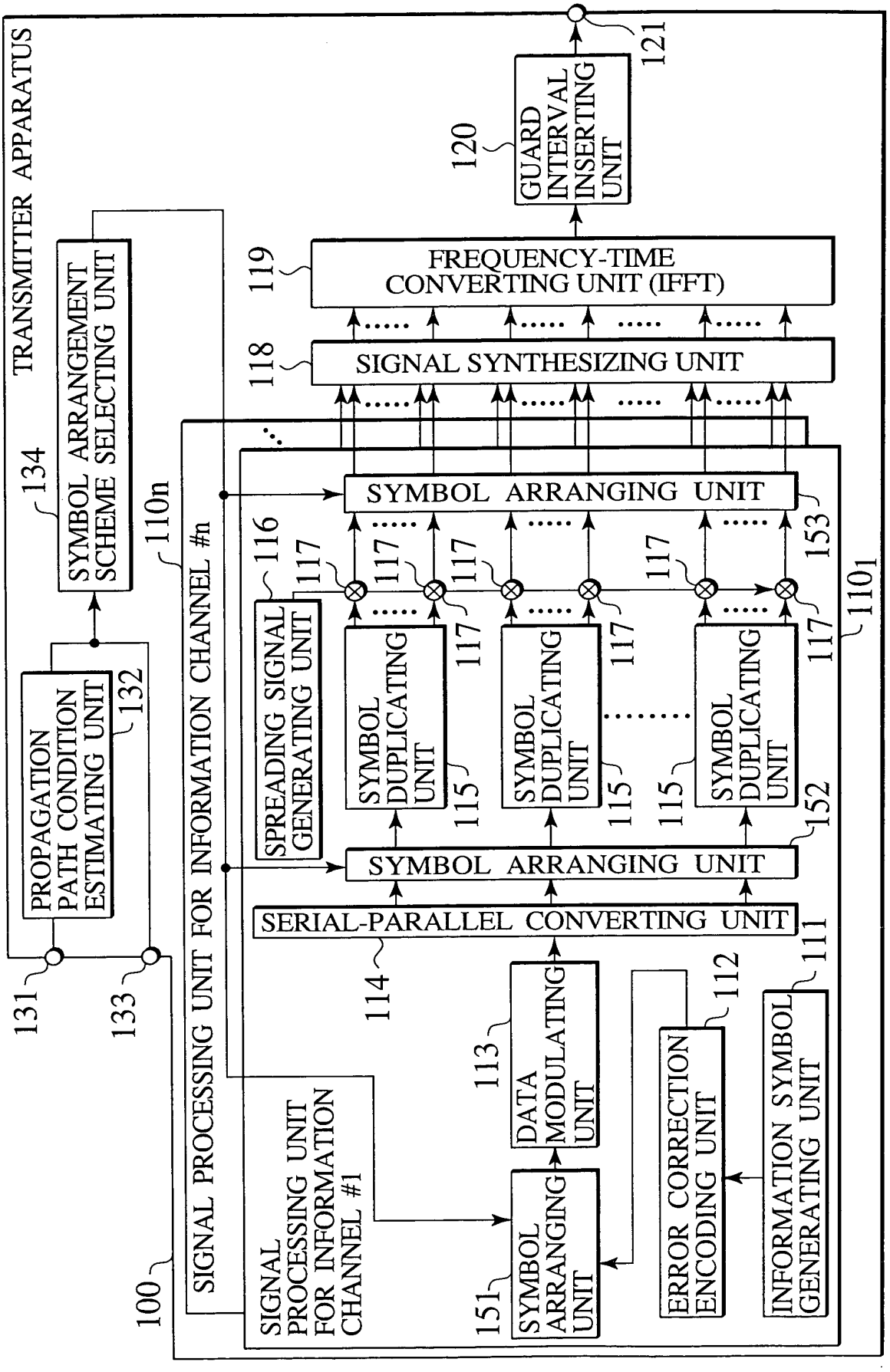

TRANSMITTER APPARATUS
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #n
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #1
PROPAGATION PATH CONDITION ESTIMATING UNIT
SYMBOL ARRANGEMENT SCHEME SELECTING UNIT
SPREADING SIGNAL GENERATING UNIT
SYMBOL DUPLICATING UNIT
SYMBOL ARRANGING UNIT
SERIAL-PARALLEL CONVERTING UNIT
DATA MODULATING UNIT
SYMBOL ARRANGING UNIT
ERROR CORRECTION ENCODING UNIT
INFORMATION SYMBOL GENERATING UNIT
SIGNAL SYNTHESIZING UNIT
FREQUENCY-TIME CONVERTING UNIT (IFFT)
GUARD INTERVAL INSERTING UNIT
100
131
133
134
110n
110₁
111
112
113
114
115
116
117
118
119
120
121
151
152
153
132

FIG. 6

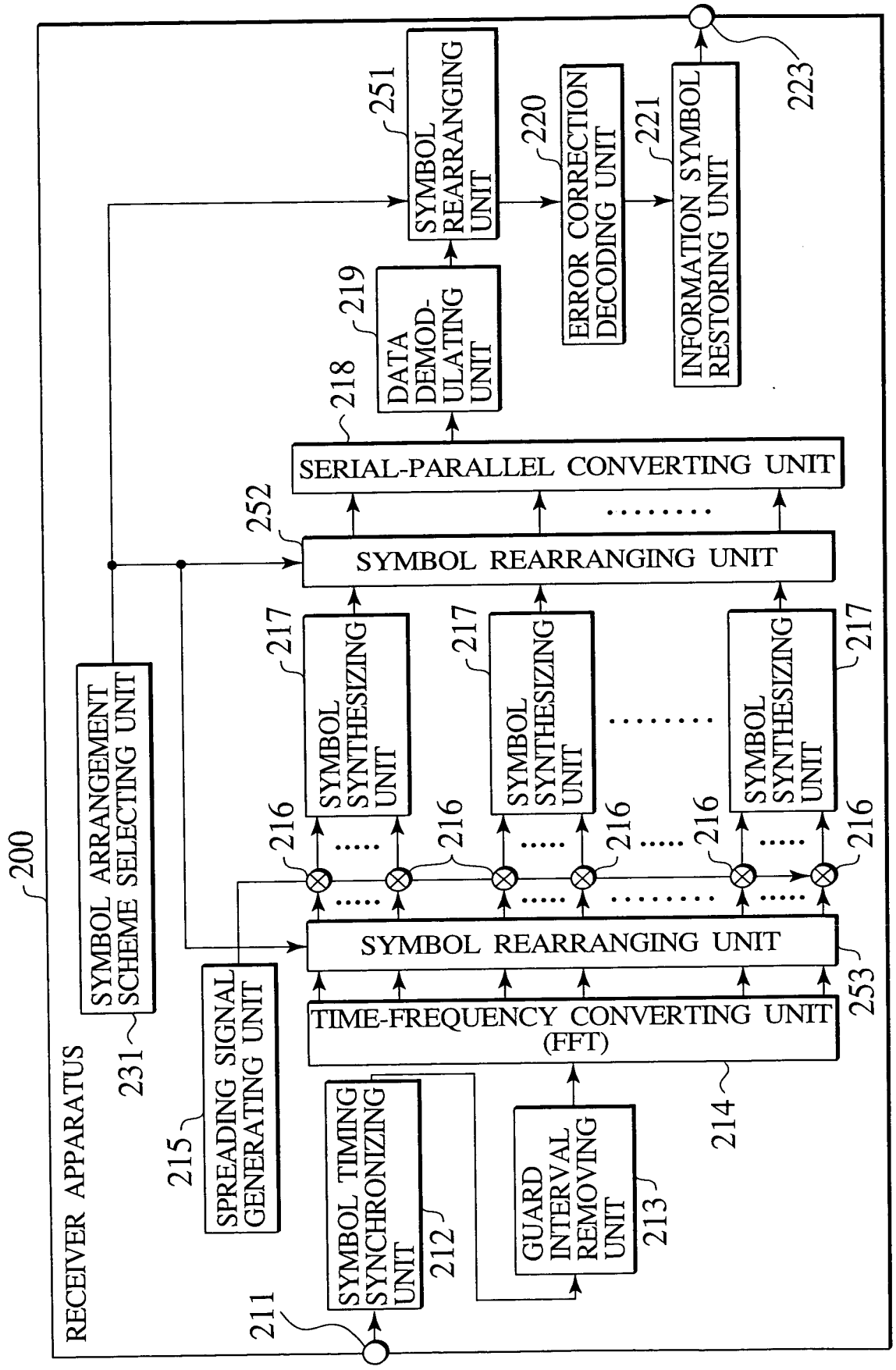

200
RECEIVER APPARATUS
211
SYMBOL TIMING SYNCHRONIZING UNIT
212
GUARD INTERVAL REMOVING UNIT
213
214
TIME-FREQUENCY CONVERTING UNIT (FFT)
253
SYMBOL REARRANGING UNIT
215
SPREADING SIGNAL GENERATING UNIT
231
SYMBOL ARRANGEMENT SCHEME SELECTING UNIT
216
217
SYMBOL SYNTHESIZING UNIT
252
SYMBOL REARRANGING UNIT
SERIAL-PARALLEL CONVERTING UNIT
218
219
DATA DEMOD-ULATING UNIT
251
SYMBOL REARRANGING UNIT
220
ERROR CORRECTION DECODING UNIT
221
INFORMATION SYMBOL RESTORING UNIT
223

FIG. 7

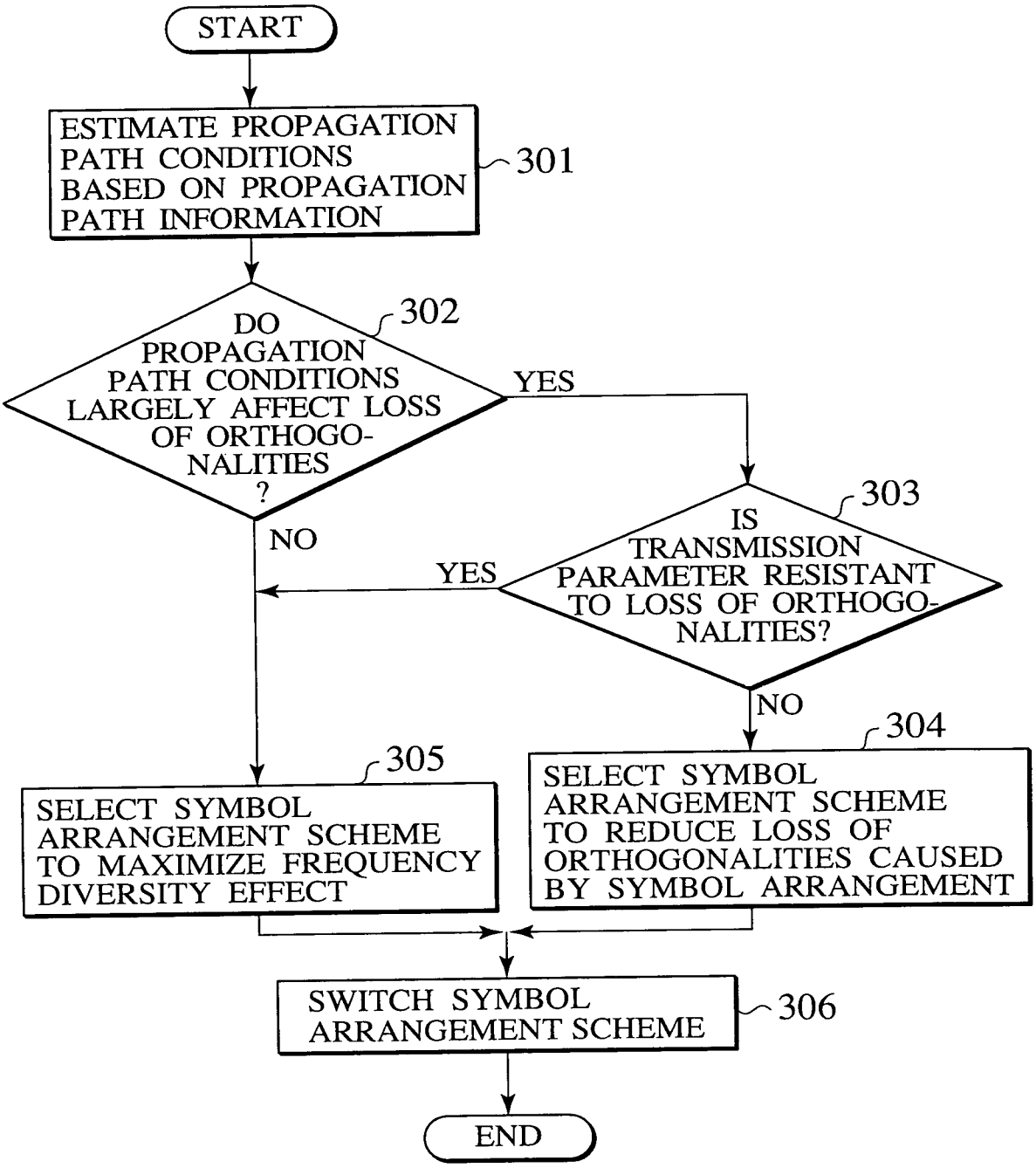

START
ESTIMATE PROPAGATION PATH CONDITIONS BASED ON PROPAGATION PATH INFORMATION
301
DO PROPAGATION PATH CONDITIONS LARGELY AFFECT LOSS OF ORTHOGO-NALITIES ?
302
YES
NO
IS TRANSMISSION PARAMETER RESISTANT TO LOSS OF ORTHOGO-NALITIES?
303
YES
NO
SELECT SYMBOL ARRANGEMENT SCHEME TO MAXIMIZE FREQUENCY DIVERSITY EFFECT
305
SELECT SYMBOL ARRANGEMENT SCHEME TO REDUCE LOSS OF ORTHOGONALITIES CAUSED BY SYMBOL ARRANGEMENT
304
SWITCH SYMBOL ARRANGEMENT SCHEME
306
END

FIG. 8

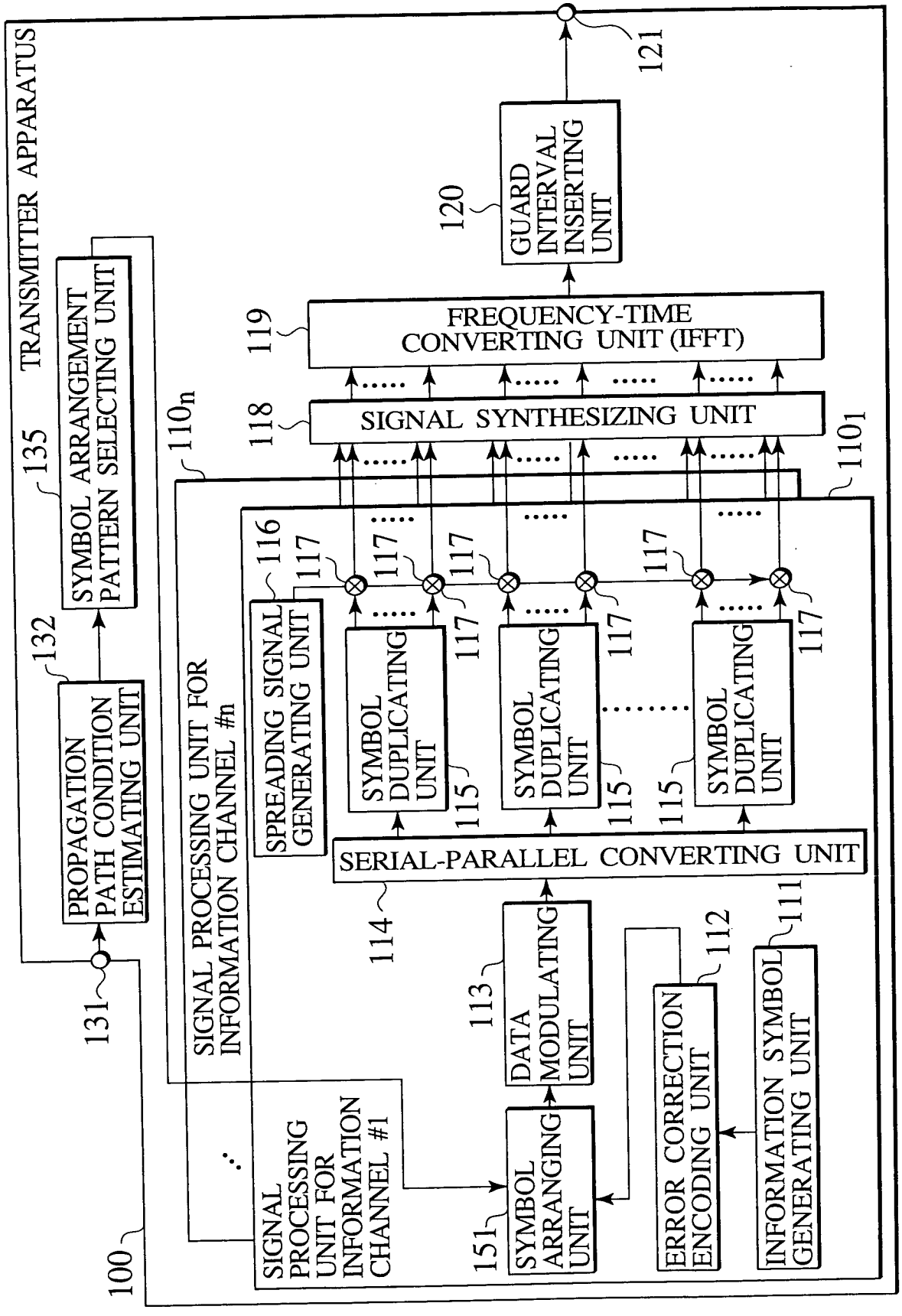

TRANSMITTER APPARATUS
100
131
PROPAGATION PATH CONDITION ESTIMATING UNIT
132
SYMBOL ARRANGEMENT PATTERN SELECTING UNIT
135
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #1
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #n
110_n
110_1
SYMBOL ARRANGING UNIT
151
DATA MODULATING UNIT
113
ERROR CORRECTION ENCODING UNIT
112
INFORMATION SYMBOL GENERATING UNIT
111
SERIAL-PARALLEL CONVERTING UNIT
114
SPREADING SIGNAL GENERATING UNIT
116
SYMBOL DUPLICATING UNIT
115
117
SIGNAL SYNTHESIZING UNIT
118
FREQUENCY-TIME CONVERTING UNIT (IFFT)
119
GUARD INTERVAL INSERTING UNIT
120
121

FIG. 9

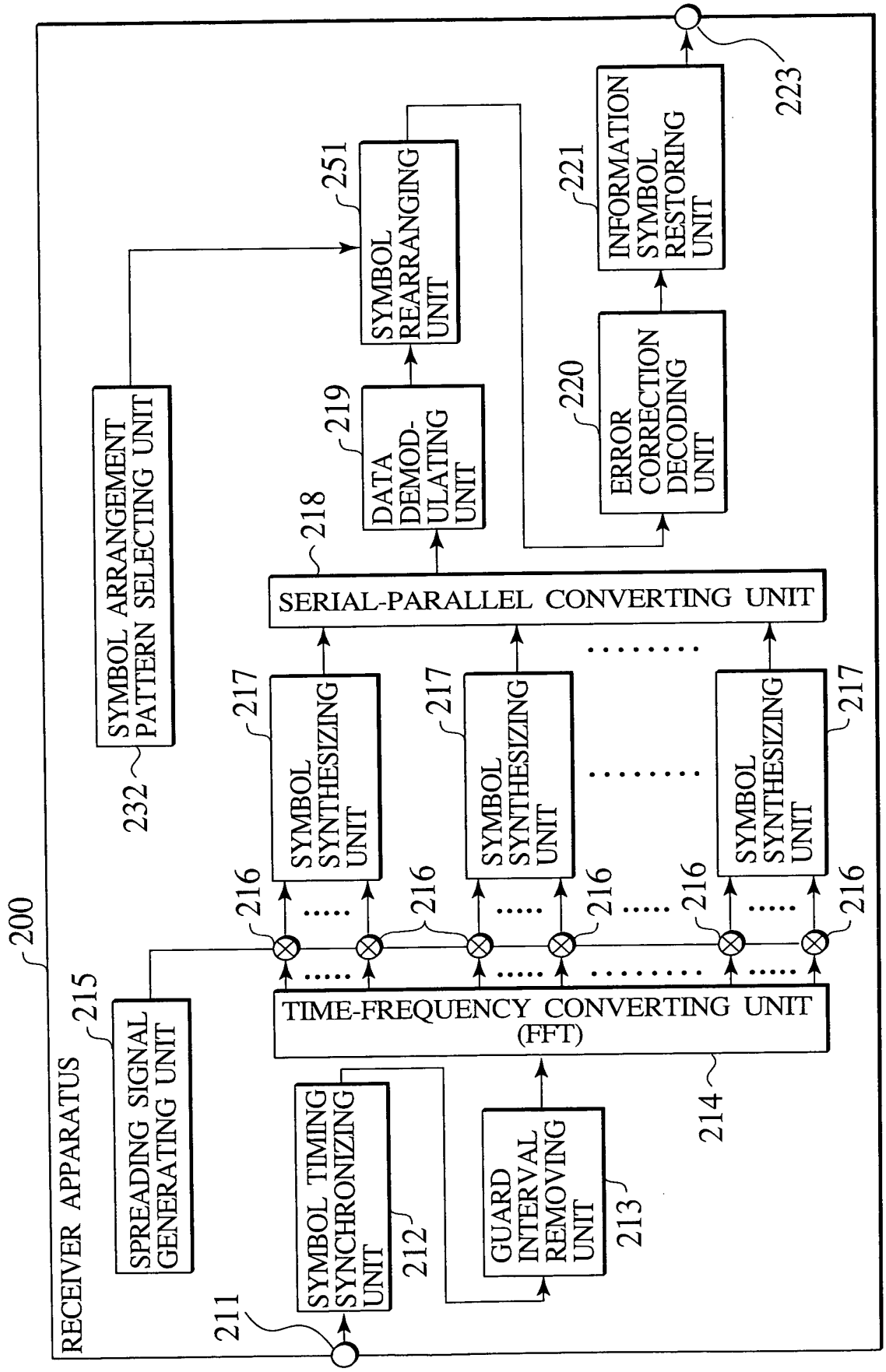

RECEIVER APPARATUS
200
211
SYMBOL TIMING SYNCHRONIZING UNIT
212
GUARD INTERVAL REMOVING UNIT
213
214
TIME-FREQUENCY CONVERTING UNIT (FFT)
215
SPREADING SIGNAL GENERATING UNIT
216
SYMBOL SYNTHESIZING UNIT
217
SERIAL-PARALLEL CONVERTING UNIT
218
DATA DEMOD-ULATING UNIT
219
ERROR CORRECTION DECODING UNIT
220
INFORMATION SYMBOL RESTORING UNIT
221
223
SYMBOL REARRANGING UNIT
251
SYMBOL ARRANGEMENT PATTERN SELECTING UNIT
232

FIG. 10

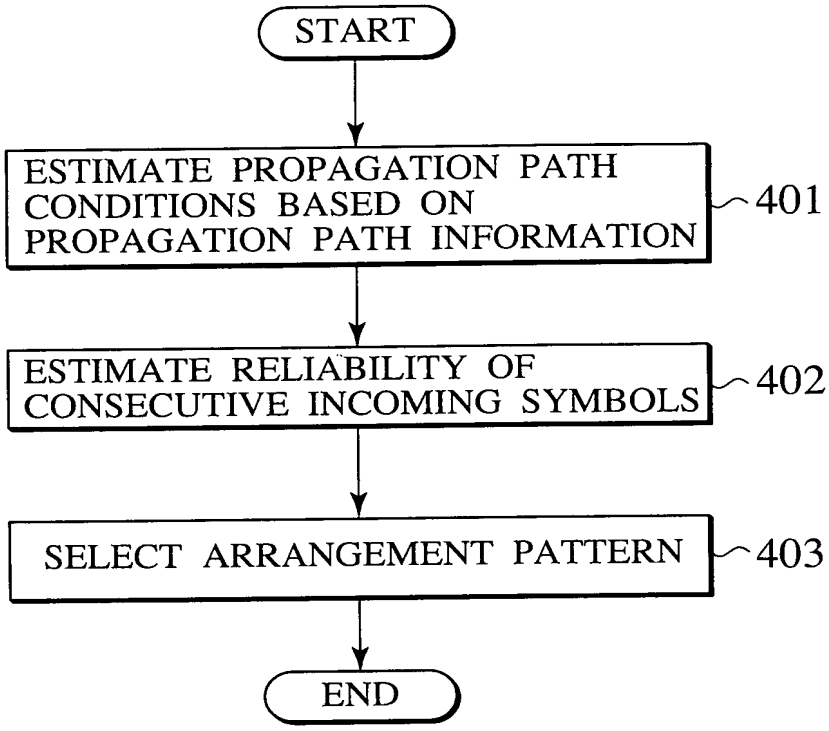

START
ESTIMATE PROPAGATION PATH CONDITIONS BASED ON PROPAGATION PATH INFORMATION
401
ESTIMATE RELIABILITY OF CONSECUTIVE INCOMING SYMBOLS
402
SELECT ARRANGEMENT PATTERN
403
END

FIG. 11

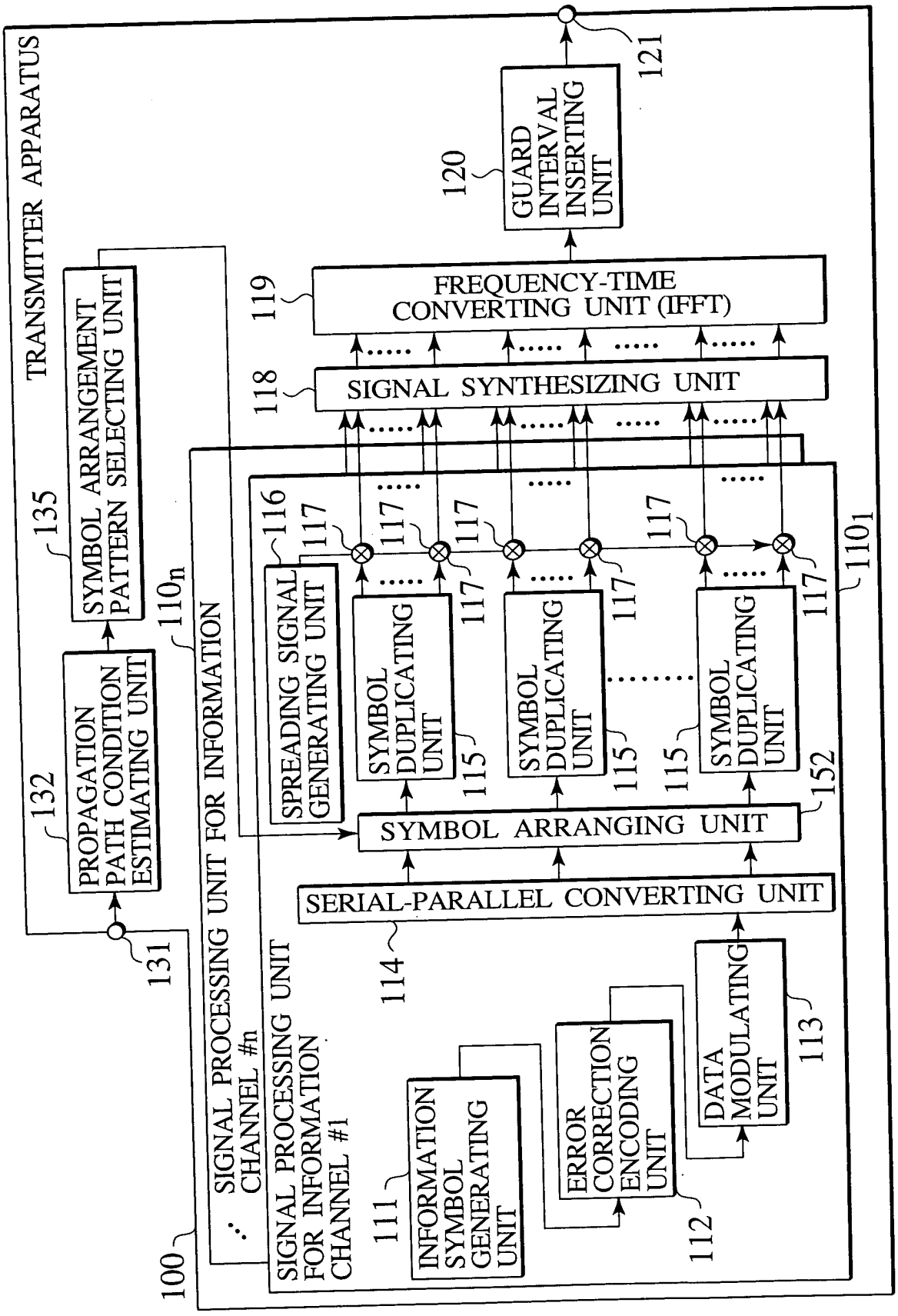

TRANSMITTER APPARATUS
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #1
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #n
INFORMATION SYMBOL GENERATING UNIT
ERROR CORRECTION ENCODING UNIT
DATA MODULATING UNIT
SERIAL-PARALLEL CONVERTING UNIT
SYMBOL ARRANGING UNIT
SPREADING SIGNAL GENERATING UNIT
SYMBOL DUPLICATING UNIT
SIGNAL SYNTHESIZING UNIT
FREQUENCY-TIME CONVERTING UNIT (IFFT)
GUARD INTERVAL INSERTING UNIT
PROPAGATION PATH CONDITION ESTIMATING UNIT
SYMBOL ARRANGEMENT PATTERN SELECTING UNIT
100
111
112
113
114
115
116
117
118
119
120
121
131
132
135
152
110_1
110_n

FIG. 12

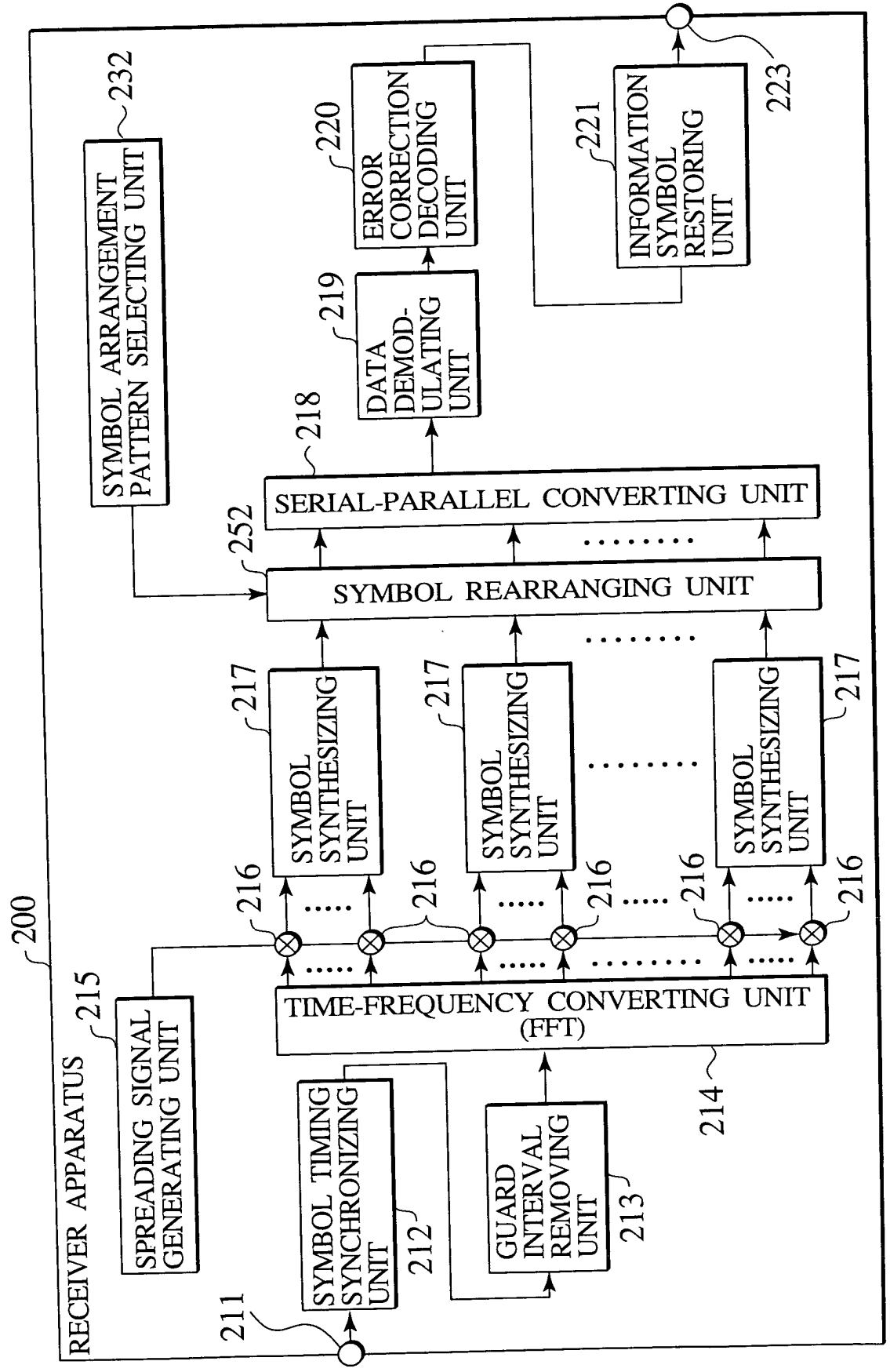

RECEIVER APPARATUS
200
211
SYMBOL TIMING SYNCHRONIZING UNIT
212
GUARD INTERVAL REMOVING UNIT
213
TIME-FREQUENCY CONVERTING UNIT (FFT)
214
SPREADING SIGNAL GENERATING UNIT
215
216
SYMBOL SYNTHESIZING UNIT
217
SYMBOL REARRANGING UNIT
252
SERIAL-PARALLEL CONVERTING UNIT
218
DATA DEMOD-ULATING UNIT
219
ERROR CORRECTION DECODING UNIT
220
INFORMATION SYMBOL RESTORING UNIT
221
223
SYMBOL ARRANGEMENT PATTERN SELECTING UNIT
232

FIG. 13

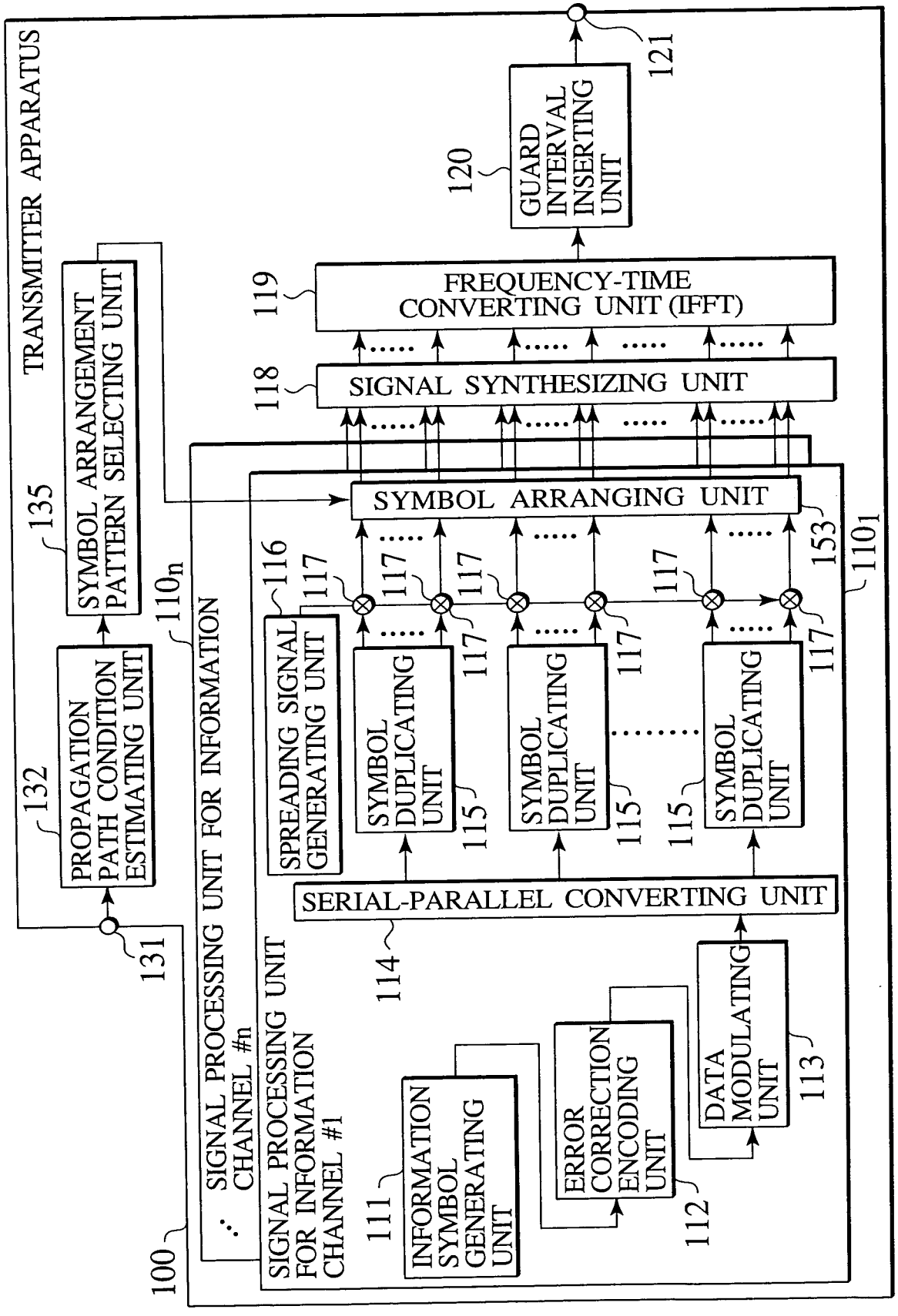

TRANSMITTER APPARATUS
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #1
SIGNAL PROCESSING UNIT FOR INFORMATION CHANNEL #n
INFORMATION SYMBOL GENERATING UNIT
ERROR CORRECTION ENCODING UNIT
DATA MODULATING UNIT
SERIAL-PARALLEL CONVERTING UNIT
SPREADING SIGNAL GENERATING UNIT
SYMBOL DUPLICATING UNIT
SYMBOL ARRANGING UNIT
SIGNAL SYNTHESIZING UNIT
FREQUENCY-TIME CONVERTING UNIT (IFFT)
GUARD INTERVAL INSERTING UNIT
SYMBOL ARRANGEMENT PATTERN SELECTING UNIT
PROPAGATION PATH CONDITION ESTIMATING UNIT
100
111
112
113
114
115
116
117
118
119
120
121
131
132
135
153
110n
110l

FIG. 14

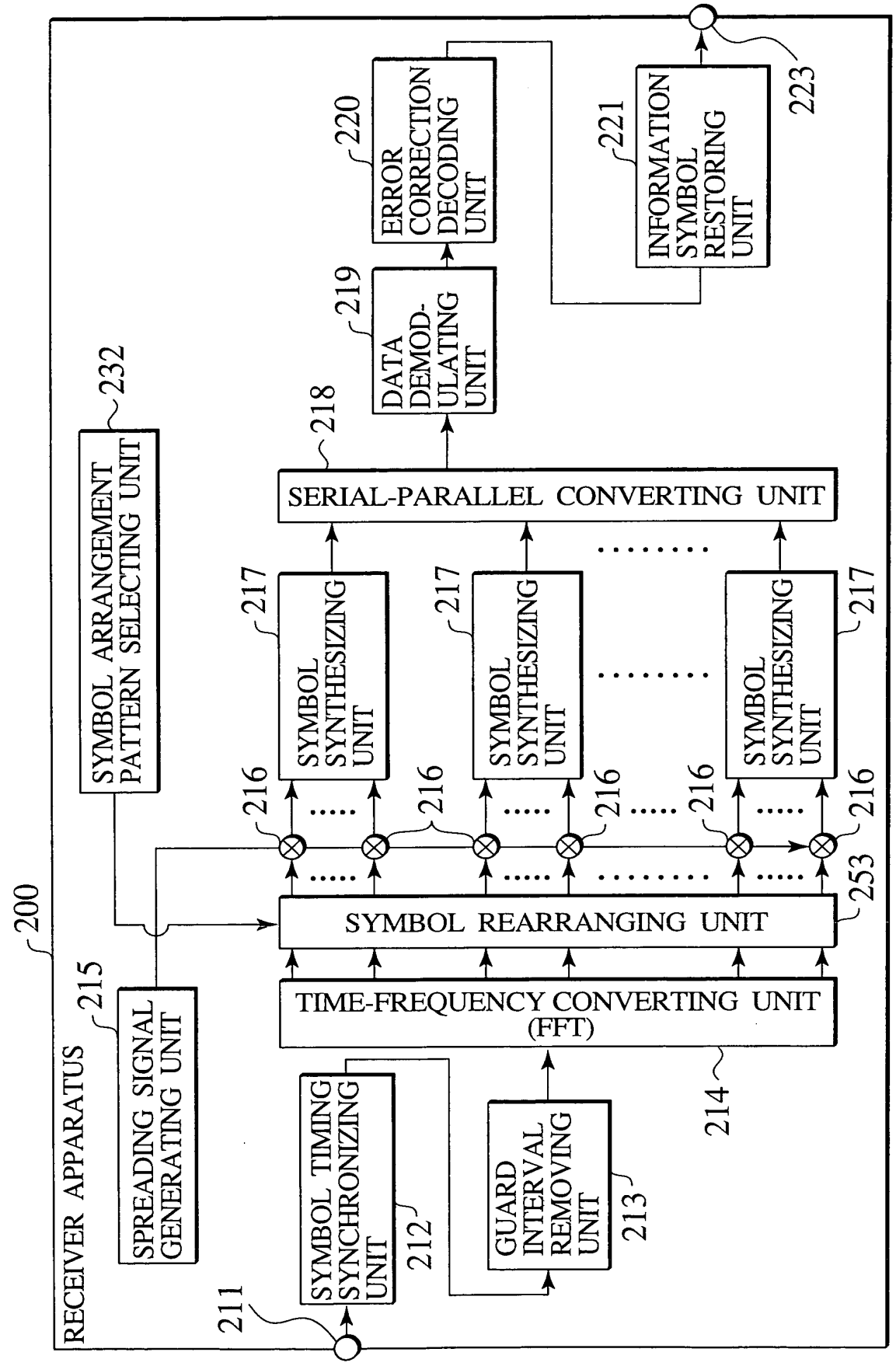
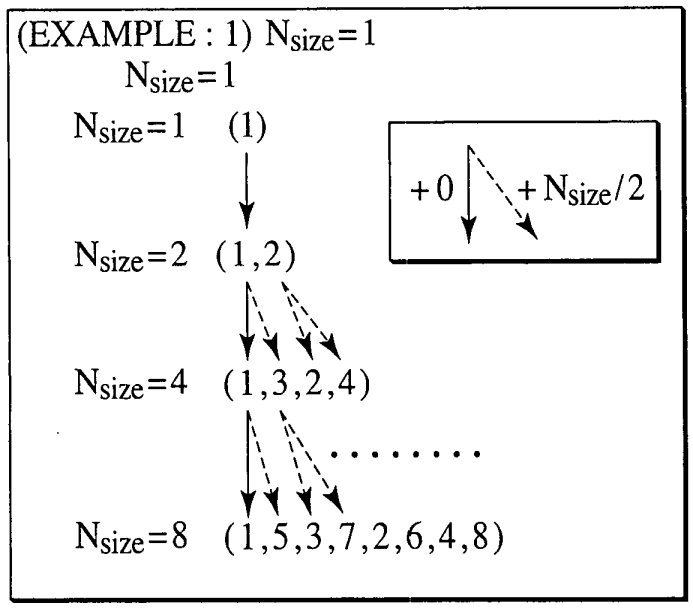

RECEIVER APPARATUS
200
211
SYMBOL TIMING SYNCHRONIZING UNIT
212
GUARD INTERVAL REMOVING UNIT
213
TIME-FREQUENCY CONVERTING UNIT (FFT)
214
SPREADING SIGNAL GENERATING UNIT
215
SYMBOL ARRANGEMENT PATTERN SELECTING UNIT
232
SYMBOL REARRANGING UNIT
253
SYMBOL SYNTHESIZING UNIT
217
216
SERIAL-PARALLEL CONVERTING UNIT
218
DATA DEMOD-ULATING UNIT
219
ERROR CORRECTION DECODING UNIT
220
INFORMATION SYMBOL RESTORING UNIT
221
223

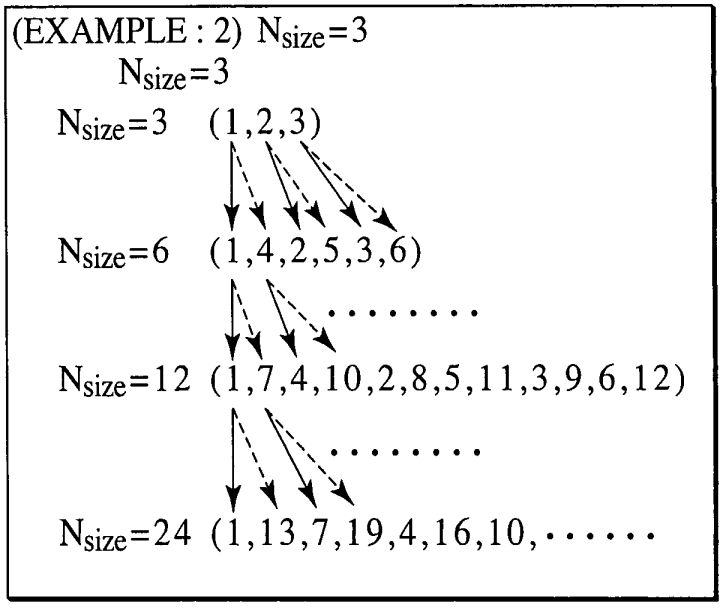
FIG. 15

ORDER OF INFORMATION SYMBOLS BEFORE ARRANGEMENT	$(1, 2, 3, \cdots, N_{size}-1, N_{size})$
ORDER OF INFORMATION SYMBOLS AFTER ARRANGEMENT	$(X_1, X_1+N_{size}/2, X_2, X_2+N_{size}/2, \cdots, X_{Nsize}/2, X_{Nsize}/2+N_{size}/2)$

N_{size} : NUMBER OF INFORMATION SYMBOLS IN ARRANGEMENT PATTERN TO BE GENERATED

X_i : i-TH COMPONENT OF BASIC ARRANGEMENT PATTERN





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